OTOLITH MICROSTRUCTURE ANALYSES IN CULTURED ATLANTIC BLUEFIN TUNA LARVAE AS A TOOL TO PROVIDE ACCURATE ESTIMATES OF SIZE SELECTIVE GROWTH AND MORTALITY

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Introduction

In bluefin tuna aquaculture, mortality during the larval production represents one of the main problems. Transition from yolk sac utilization to exogenous planktivory feeding is the first bottleneck in larval survival (Hjort, 1914) and from planktivory to piscivory feeding another major one (Reglero et al., 2014). During the planktivorous feeding stages mortality is strongly size dependent with large size and fast growing larvae typically having increased survival probability (Takasuka et al., 2007). However, growth variations are apparent since the start of the piscivory (Tanaka et al., 2014) and how mortality affects the size spectrum of the larvae that manage to survive through piscivory has never been studied in Atlantic bluefin tuna (ABFT).

The growth characteristics of the fraction of the initial population that survives can be determined using the information stored in the otoliths microstructure and estimated previous size-at-age. We conducted a laboratory experiment in which ABFT larvae were offered larval prey for first time at different times to simulate early onset of piscivory (YSL), delayed onset of piscivory (DYSL) or just a plantivorous diet (Rotifers). The otolith microstructure was then used to compare the size distribution at the onset of the experiment with the estimated previous size-at-age of the survivors at the end of the experiments.

Materials and Methods

In order to test the effect of different timings of onset of piscivory has on bluefin tuna larval size survival, we conducted a series of experiments with three different feeding treatments, with five 150 l tank replicates each. In the first treatment (Rotifers), only enriched rotifers were provided as food to the larvae until the end of the experiment. In the second treatment (DYSL), four days after the start of the experiment, sea bream yolk sac larvae were added *ad libitum* in the tanks along with enriched rotifers whereas in the third treatment (YSL), sea bream yolk sac larvae were added with enriched rotifers during the entire experiment. On the first day (Eday0, 19 dph), three larvae per tank were subsampled in darkness as starting point and the last day (Eday8, 27 dph) all the surviving larvae were counted, measured and sampled for accurate growth and survival estimates.

Both *sagittae* otoliths from each sampled larva where removed, their increments and *radii* counted and measured. Increment widths were obtained by subtracting the distance from the core to the corresponding increment and the distance to the previously formed increment. Back calculation estimates to Eday0 were obtained from the Eday8 otoliths where 8 increments were counted backwards from the edge following the longest possible *post-rostrum* axis. These back-calculated otolith *radii* at Eday0 were then compared to the initially sampled otolith *radii* on Eday0 to obtain estimates of size-selective mortality within each group.

Results

Our results, based on the analysis of the sampled survivors, show that the largest and fastest growth was obtained for the early piscivory feeding group (YSL) followed by the group in which piscivory was delayed (DYSL) and then the planktivorous group (Rotifers) (Fig.1). However, our otolith back-calculated results showed that the surviving larvae at the end of the experiment were the smallest ones at the beginning of the experiment in all treatments (Fig.1). The results corroborate the rapid response of ABFT to the piscivory in terms of growth reflected in the otolith increments width.

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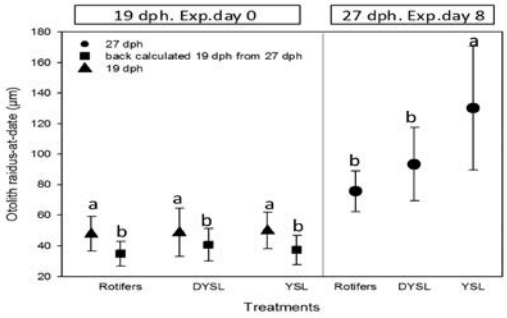

Figure 1. Otolith mean sizes from groups sampled at different dates with different letters indicating significant different otolith sizes. Initial population (triangles), final population (circles) and back-calculated data to 19 dph from survival population (squares).

Discussion

The growth differences between the three treatments may be caused by differences in the nutritional values and total energy content of the diets since rotifers are nutritiously inferior to yolk-sac larvae (Seoka et al., 2007). The surviving of the small larvae at the end of the rotifers and DYSL treatments can be explained as an agonistic behavior of the large larvae caused by the lack of suitable prey items at onset of piscivory. In the YSL treatment, it might be explained because larvae cannot express their behavior fully (Folkvord 2005), maintain the physiological machinery at maximum unlike the smallest ones and they might have been affected by a possible tank and transport effect. The mortality of the large larvae along with the rapid response of piscivory in terms of growth reflects that there is a cost within each treatment of growing fast.

Being bigger is not always the best option to survive and mortality rates do not always decline with increasing larval size. Smaller size at a given age could under certain condition and at certain stages of development confer a survival advantage on individual members of a larval cohort.

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